


Teaching Quantitative Physiology using a Flipped Classroom Approach

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BEEC Share and Learn, April 2023

Course learning outcomes

By the end of the course, students will be able to…

1. Understand the structure and function of the nervous and musculoskeletal systems, as well as how disease alters these characteristics.
2. Apply engineering models and mathematics to understand human physiology.
3. Gain experience working on a self-governed team to complete an engineering project.
4. Learn about biomedical devices to restore or enhance human function by identifying and reading relevant primary sources.
5. Apply newly-acquired knowledge of biomedical devices to the design of a new device.
6. Design a device enabling humans to recover lost function or enhance existing function.

4 Blocks:

1. **Brain/Neurons**
2. **Auditory System**
3. **Muscles**
4. **Motor Control**

The structure of the course

- Mondays
  - No live class; students watch videos of lecture material & take notes
- Wednesdays
  - Students take 10-question video quiz prior to lecture
  - In class, students do small group exercises with instructor & TA guidance
- Fridays
  - Students take a survey prior to class to suggest topics and ask questions
  - In class, the instructor reviews material, answers questions; can also do more group exercises

Assessment

- Video quizzes: 1% x 10, pass/fail; on Canvas
- Flashcard quizzes: 2% x 4, pass/fail with unlimited retakes; on Canvas
- Block quizzes: 6% x 4; on Canvas, open notes, can be taken in groups
- Problem-based learning project
  - Background research (written report): 15%
  - Design challenge (video): 15%
- Final exam: 28%, individual, in person

- Frequent small, low-pressure opportunities for learning and asking questions
- Students have 10 full weeks to learn, make mistakes, ask questions

- An individual assessment at the end of class measures how much they learned

- Final exam questions have a structure similar to the in-class group exercises, so attending those sessions is the best way to practice

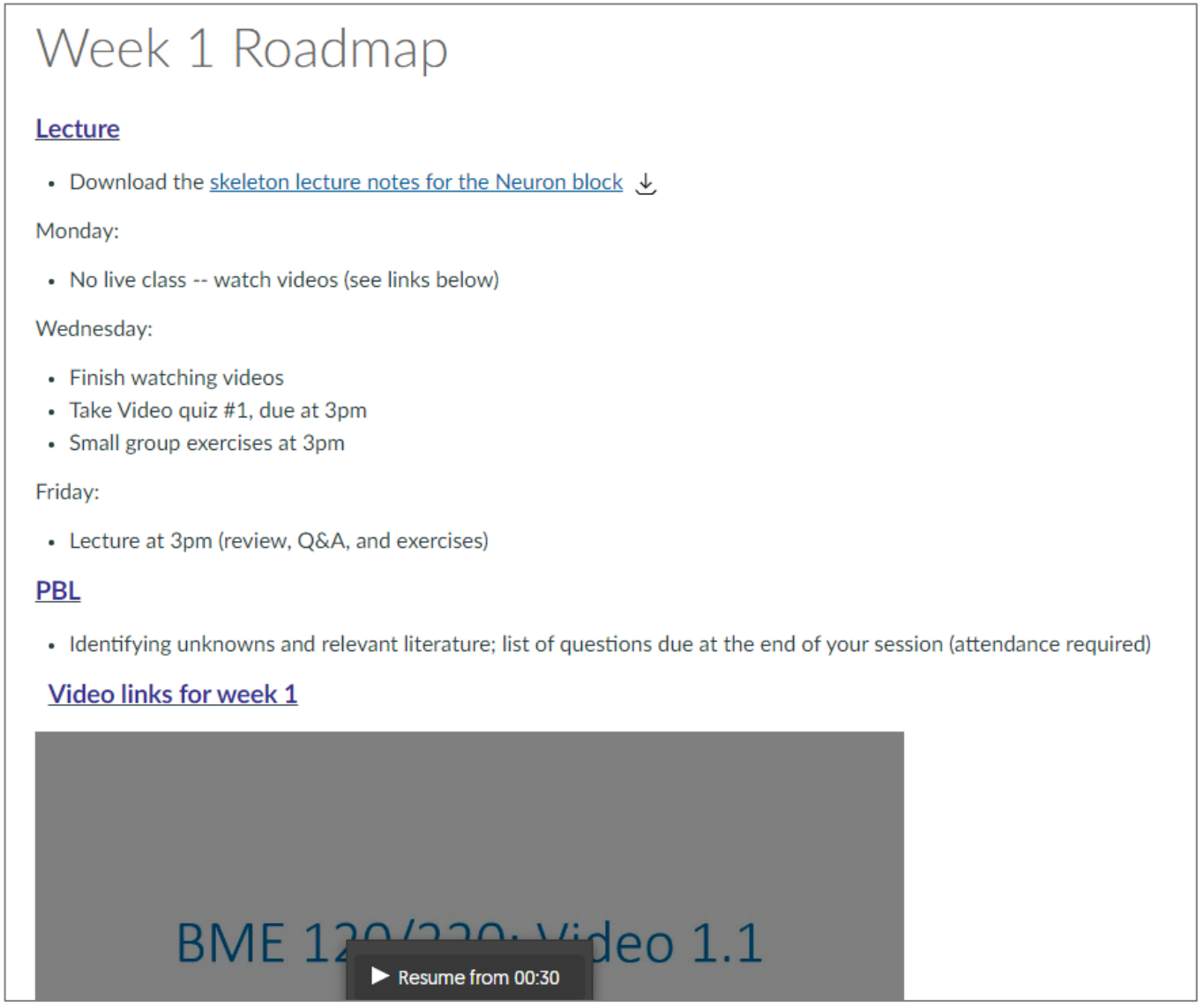
Course learning outcomes

By the end of the course, students will be able to…

1. Understand the structure and function of the nervous and musculoskeletal systems, as well as how disease alters these characteristics. (Lecture, quizzes, group exercises)
2. Apply engineering models and mathematics to understand human physiology. (Lecture, quizzes, group exercises)
3. Gain experience working on a self-governed team to complete an engineering project. (PBL)
4. Learn about biomedical devices to restore or enhance human function by identifying and reading relevant primary sources. (Lecture, PBL)
5. Apply newly-acquired knowledge of biomedical devices to the design of a new device. (PBL)
6. Design a device enabling humans to recover lost function or enhance existing function. (PBL)

Canvas has a roadmap for every week

- Weekly structure stays as consistent as possible to avoid confusion

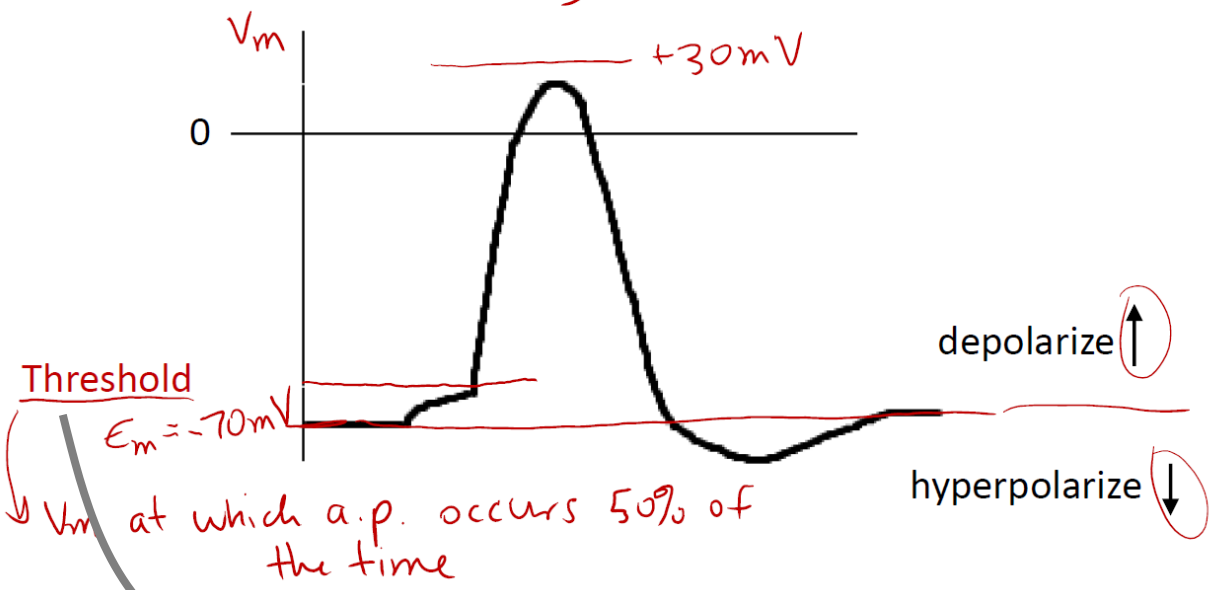


What are the videos like?

Video slide 1

Section 7: The action potential

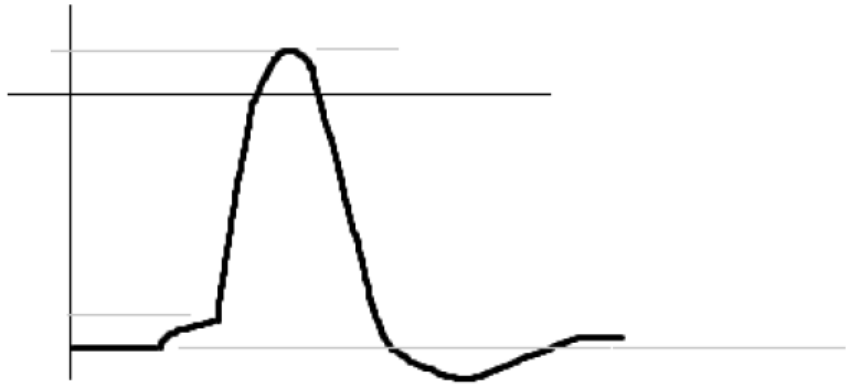
7A. The action potential (a.p.)



Skeleton notes given to students

Section 7: Synaptic transmission and the action potential

7A. The action potential



Threshold =

Absolute refractory period =

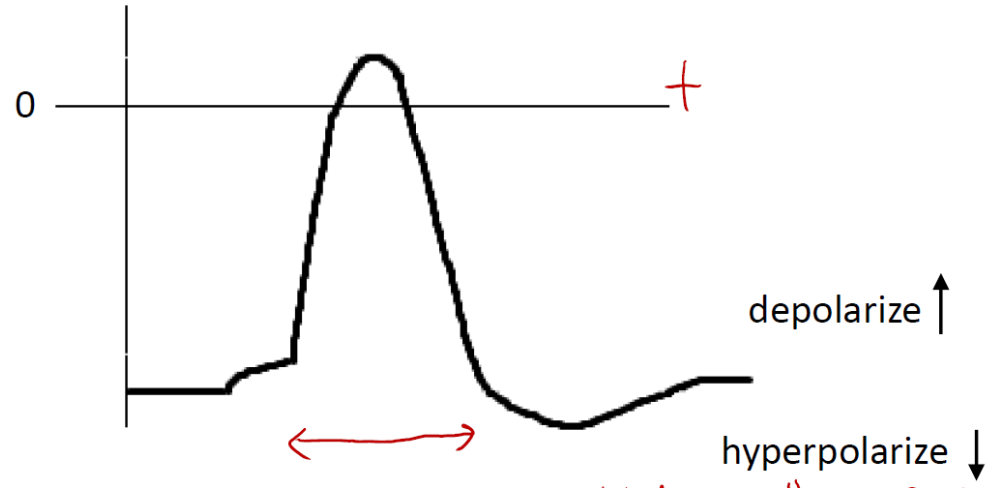
Relative refractory period =

What are the videos like?

Video slide 2

Section 7: The action potential

7A. The action potential

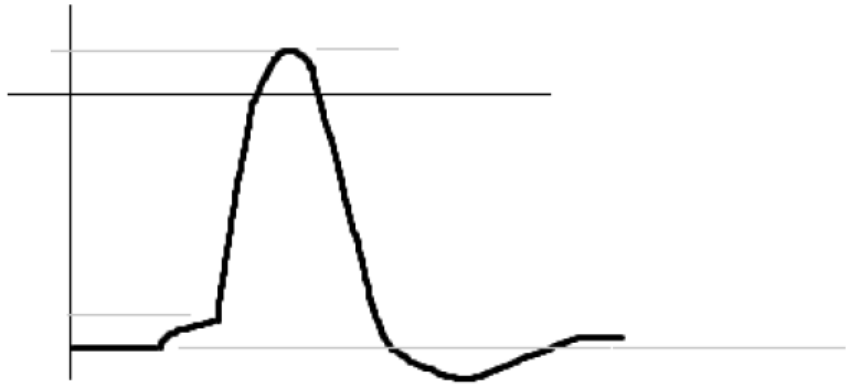


Absolute refractory period = time during which another a.p. cannot occur

Skeleton notes given to students

Section 7: Synaptic transmission and the action potential

7A. The action potential



Threshold =

Absolute refractory period =

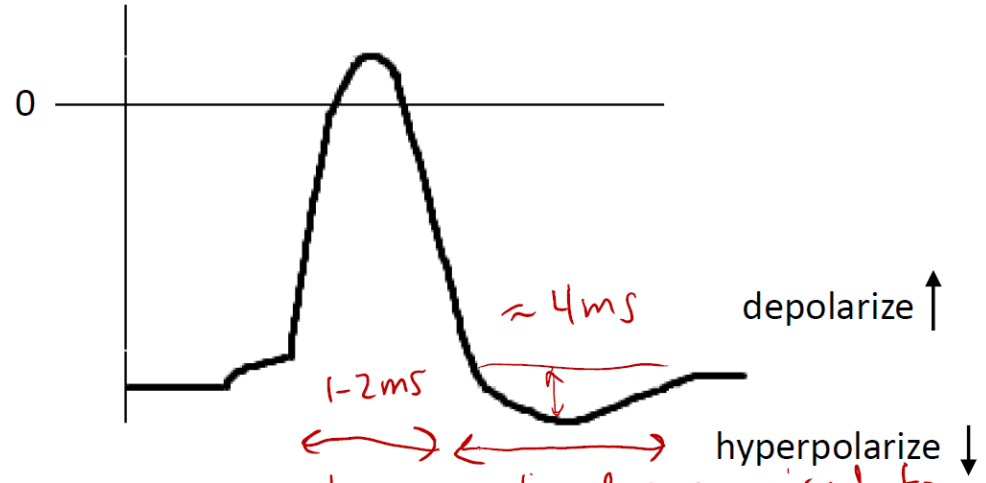
Relative refractory period =

What are the videos like?

Video slide 3

Section 7: The action potential

7A. The action potential

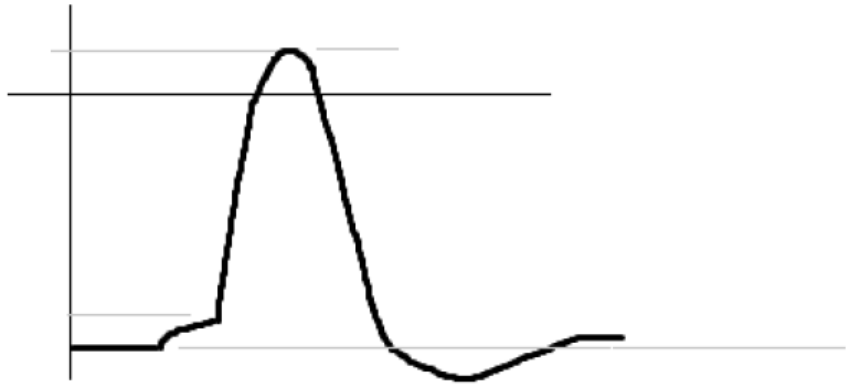


Relative refractory period = stronger stimulus required to elicit second a.p.

Skeleton notes given to students

Section 7: Synaptic transmission and the action potential

7A. The action potential



Threshold =

Absolute refractory period =

Relative refractory period =

Do students really watch the videos?

- I upload videos to Yuja → embed in Canvas
- Yuja can provide detailed analytics for each video
  - Number of views
  - Number of unique views
  - Number of views at every single time point
  - Sessions for individual students including names (sometimes “anonymous”), dates, duration watched, how many times it was watched
  - Etc.

Do students really watch the videos? YES.

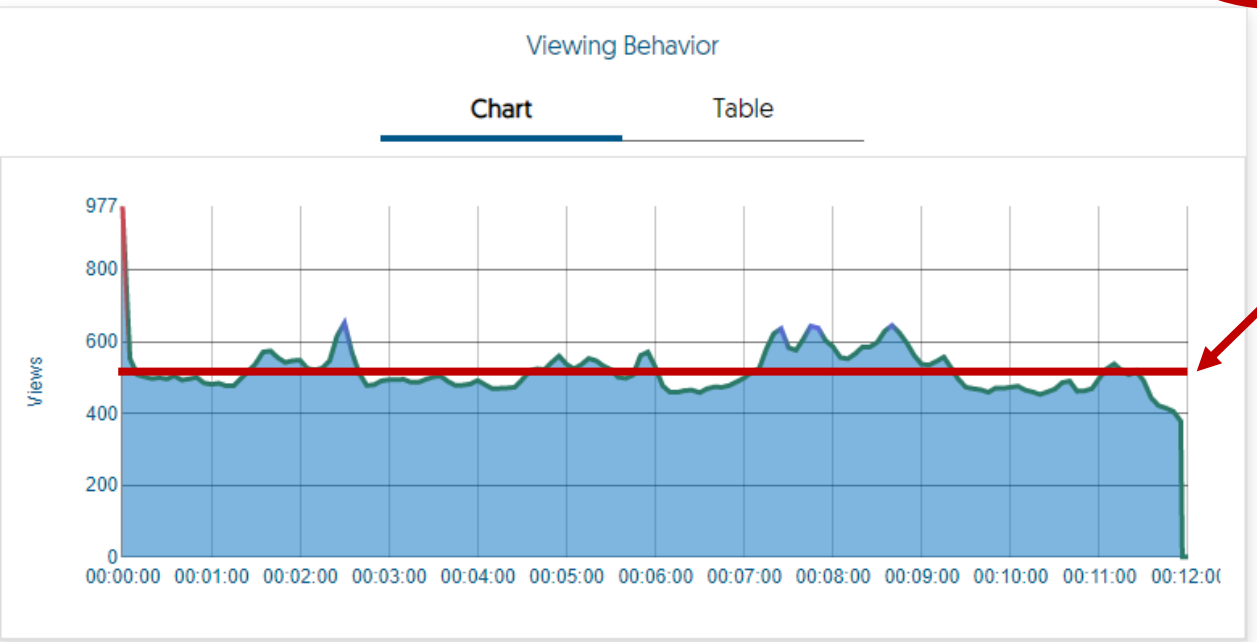
- The first video of the course:

Over two years, ~90% of students watched some part of the video

Enrollment in 2020: 214
Enrollment in 2021: 167
TOTAL: 381

Summary | Playback | Sessions | Bandwidth | Technology | Segment Views | Session Dates

00:11:56	137.75	881	344	06:17:00	100%	0
Duration	Size (MB)	Views	Unique Views	Total Play Length	Play Percentage	Video Downloads



Average number of views is ~500, and this stays constant throughout the duration of the video. Therefore…

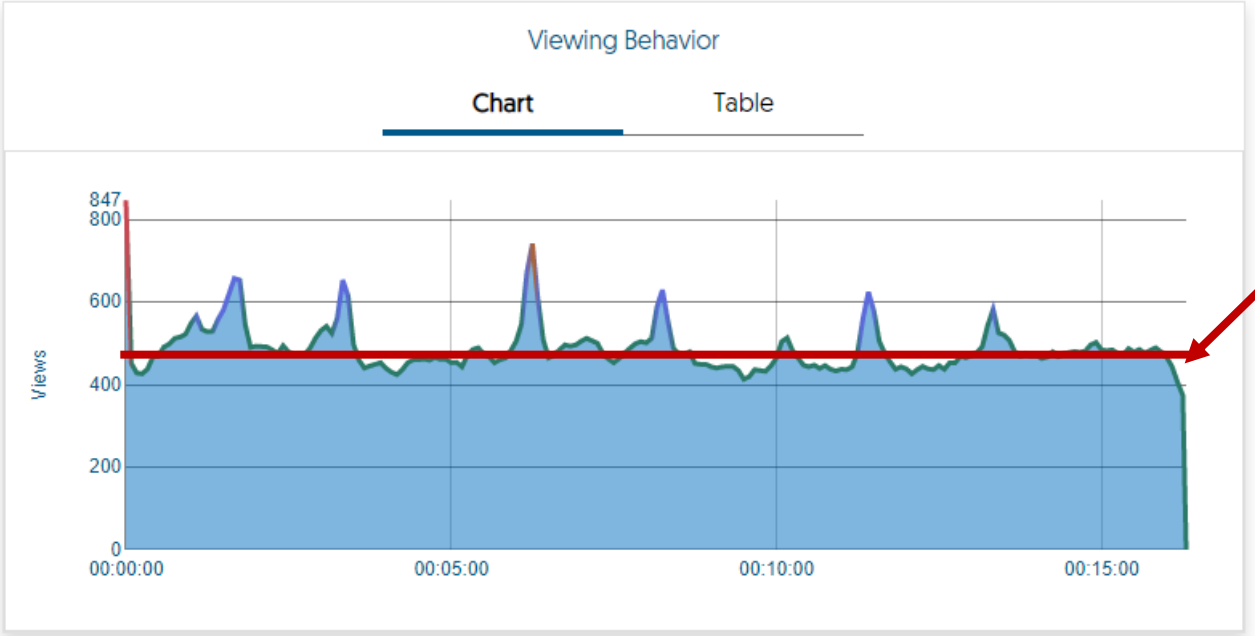
- Most students watched the whole video
- Many students watched it more than once

Do students really watch the videos? YES.

- The last video of the class:

85% of students over two years

Summary	Playback	Sessions	Bandwidth	Technology	Segment Views	Session Dates
00:16:18 Duration	152.35 Size (MB)	757 Views	323 Unique Views	11:21:35 Total Play Length	100% Play Percentage	0 Video Downloads



Average number of views is ~475

The number of views stays relatively consistent throughout the quarter.

Philosophy for online quizzes

- Structure of quizzes comes from the idea of specifications grading
- Academic honesty is a concern, but assessments are structured so that students can do well without cheating (cheating won't get them a better grade)
  - Examples: Pass/fail quiz; quiz with unlimited retakes; allow students to work in groups
- Quizzes utilize question banks, shuffled answers, showing one question at a time; students cannot see the correct answers until the quiz is closed

Small group exercises in a traditional lecture hall

Block off every 3rd row, so instructors can reach students without climbing over anyone

Initial evaluation of flipped format

- Midquarter evaluation from 2020:

Method	%
Lecture videos	96
Skeleton lecture notes	91
Reviewing material from videos (Wed.)	77
Video quizzes	73
Flashcard quizzes	71
Polls and small group exercises (Wed.)	57
Group quizzes for each block	54
Small group exercises (Fri.)	50
Discussion section with TAs	36
Problem-based learning project	33
Textbook	20
Canvas discussion board	19
Office hours	17

Table 1. *Percent of students indicating that the particular teaching method helped them learn. Rows shaded gray were new in 2020.*

My impression of the student perspective

- The course is flexible
  - Watch & rewatch lecture material whenever you want
  - All quizzes are available for 24 hours or more (often several days or weeks)
  - Attendance at lecture is not required
- The course is tailored to students
  - Friday lectures are based solely on their questions
  - Instructor and TAs are present on Wednesdays to answer questions
- Group quizzes/exercises provide opportunities for peer learning
- Videos encourage engagement (note taking) and can be watched in real time
- Every week, material is repeated in multiple forms (videos, lecture, video quiz, flashcard practice, group exercises)

The instructor’s perspective

- No need to repeat the same lecture every year
- Spend more time teaching the most difficult content
- No worries about falling behind on lecture material
- Teaching is more interactive (= more fun); working with smaller groups, answering specific questions
- The use of Canvas quizzes drastically reduces the amount of grading
- Can instantly switch to remote teaching

Thanks! Questions?